FORM PTO-1390 (REV 5-93) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 2046/48639

U S APPLICATION NO (if known, see 37 CFR 1 5): 09/486264

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/CH98/00346	18 August 1998	26 August 1997

TITLE OF INVENTION
REINFORCEMENT DEVICE FOR SUPPORTING STRUCTURES

APPLICANT(S) FOR DO/EO/US
SCHWEGLER, Gregor

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (unexecuted).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern other document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [X] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:

Copies of (1) First page of int'l pub. no. WO 99/10613; (2) Request Form, PCT/RO/101 (4 pages); (3) Form PCT/IB/308; (4) International Search Report; (5) International Preliminary Examination Report; and (6) Request Form, PCT/IPEA/401 (4 pages)

U S APPLICATION NO (if known, see 37 CFR 1.5) 09/486264	INTERNATIONAL APPLICATION NO PCT/CH98/00346	ATTORNEY'S DOCKET NUMBER 2046/48639

17. [X] The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Search Report has been prepared by the EPO or JPO $840.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $670.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482)		
but international search fee paid to USPTO (37 CFR 1.445(a)(2) $690.00		
Neither international preliminary examination fee (37 CFR 1.482) nor		
international search fee (37CFR 1.445(a)(2) paid to USPTO ..... $ 970.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482)		
and all claims satisfied provisions of PCT Article 33(2)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130.00	

Claims	Number Filed	Number Extra	Rate		
Total Claims	16-20=	0	X $18.00	$ 0	
Independent Claims	2-3=	0	X $78.00	$ 0	
Multiple dependent claims(s) (if applicable)			+ $260.00	$ 0	
			TOTAL OF ABOVE CALCULATIONS =	$ 970.00	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$ 0	
			SUBTOTAL =	$ 970.00	
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ 0	
			TOTAL NATIONAL FEE =	$ 970.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). $40.00 per property +				$ 0	
			TOTAL FEE ENCLOSED =	$ 970.00	
			Amount to be: refunded	$	
			charged	$	

a. [X] A check in the amount of $ 970.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment to Deposit Account No. 05-1323 (2046/48639). A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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REGISTRATION NUMBER

February 25, 2000

DATE

Attorney Docket: 2046/48639
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Gregor Schwegler

Serial No.: Not Yet Assigned
(PCT Appln. No. PCT/CH98/00346)

Filed: February 25, 2000
(PCT Appln. Date: August 18, 1998)

Title: REINFORCEMENT DEVICE FOR SUPPORTING STRUCTURES

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend this application as follows prior to examination:

Please add the Abstract of the Disclosure attached as Appendix I hereto after the last page of the translation.

Please replace pages 1-6 of the translation with the substitute specification attached as Appendix II.

IN THE CLAIMS:

Please amend claims 1-14 as follows:

1. (Amended) Reinforcing device for supporting structures [(1) with CFK] comprising:

a carbon panel [(2) characterized in that], at least one end of [CFK] the carbon panel [(2) is] being split into at least two strips [(2')], and

[terminates in] an end element [(3, 4; 12, 13)] in which said at least one end terminates.

2. (Amended) Reinforcing device according to Claim 1 [characterized in that] wherein each of [the] two ends of [CFK] the carbon panel [(2)] terminates in an end element [(3, 4; 12, 13)].

3. (Amended) Reinforcing device according to Claim 1 [or 2 characterized in that] wherein the strips [(2')] are inserted at least partially into retaining slots [(9; 9')] of the end element [(3, 4; 12, 13)] that are [preferably] located wedgewise relative to one another.

4. (Amended) Reinforcing device according to [one of Claims] Claim 1 [to 3 characterized in that] wherein each end of the panel [ends (2') are] is split into superimposed strips of approximately equal thickness.

5. (Amended) Reinforcing device according to [one of Claims 1 to 4 characterized in that] Claim 3 wherein said retaining slots [(9)] of the end element [(3, 4; 12, 13)] have a rough or corrugated surface.

6. (Amended) Reinforcing device according to [one of Claims 1 to 5 characterized in that] Claim 3 wherein bores [(10) located] oriented transversely to the surface of the panel are located in the end element [(3)] in the vicinity of said retaining slots [(9)].

7. (Amended) Reinforcing device according to [one of Claims 1 to 6 characterized in that] Claim 1 wherein the end element [(3, 4; 12, 13)] is a parallelepiped made of metal or plastic.

8. (Amended) Reinforcing device according to [one of Claims 1 to 7 characterized in that] Claim 1 wherein the end element [(3, 4; 12, 13)] in the vicinity of the outlet of the [CFK] carbon panel [(2)] has reinforcing devices [(11), preferably threaded bolts,] located transversely to [the] an outlet direction.

9. (Amended) Reinforcing device according to [one of Claims 1 to 8 characterized in that] Claim 1 wherein the end

element [(3, 4; 12, 13)] has a force-introduction point[, preferably a threaded bore (12)] opposite the outlet of the [CFK] carbon panel.

10. (Amended) Reinforcing device according to [one of Claims 1 to 9 characterized in that] Claim 3 wherein the retaining slots [(9)] are located wedgewise in the end element [(3, 4; 12, 13) in] such [fashion] that [the] a lowest retaining slot [(9')] is parallel to the outlet direction of the carbon panel [(2)] and each of the other retaining slots [(9) are each] is located fanwise with an increasing angle from the outlet opening.

11. (Amended) Method for reinforcing supporting elements [(1)] with reinforcing devices [according to one of Claims 1 to 10 characterized in that the CFK] comprising:

cutting carbon panels [(2) cut] to [the] an appropriate length [are separated or split],

separating or splitting each panel at at least one end into at least two strips [(2')] of approximately the same thickness or width [and are brought],

bringing the at least one end into a connection with an end element [(3, 4; 12, 13)], and [this]

gluing the arrangement [is glued] to [the] a tension side of [the] a supporting element [(1)] to be reinforced.

12. (Amended) Method according to Claim 11 [characterized in that] wherein the strips [(2')] of [CFK panel (2)] approximately the same thickness or width are introduced into separate retaining slots [(9, 9')] of [an] the end element [(3, 4; 12, 13) preferably] which are arranged fanwise with respect to one another and glued [there] in place or soaked with an adhesive.

13. (Amended) Method according to Claim 11 [or 12 characterized in that] wherein each of the ends of the [CFK

strips (2) are each] carbon panels is separated or split into three strips [(2')] and the arrangement, before gluing [with] to the supporting element [(1)], is pretensioned relative to the latter by clamping means [(7, 8)] and then glued in [the] a pretensioned state to the supporting element [(1)].

14. (Amended) Method according to [one of Claims] Claim 11 [to 13 characterized in that] each of the [CFK panel (2)] carbon panels is split in [the] a fiber direction.

Please add the following new claims:

--15. Reinforcing device according to Claim 8, wherein the reinforcing devices are threaded bolts.

16. Reinforcing device according to claim 9, wherein the force-introduction point is a threaded bore.--

REMARKS

This Preliminary Amendment is being filed in order to eliminate multiple claim dependencies and otherwise improve the form of the application prior to examination.

A marked-up copy of the substitute specification, showing additions by underlining and deletions between brackets, is attached hereto as Appendix III. The substitute specification is believed to contain no new matter.

Respectfully submitted,

February 25, 2000

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[WO99/10613]
[PCT/CH98/00346]

[Reinforcing Device for Supporting Structures]

REINFORCEMENT DEVICE FOR SUPPORTING STRUCTURES

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to a reinforcing device [according to the preamble of Claim 1] as well as a method for reinforcing beams [according to the preamble of Claim 11.]

When rehabilitating supporting structures in existing buildings, the [problem often arises that the] supporting [structure is] structures often are to be adapted for new load cases that exceed the former dimensions. In order to avoid replacing [the] a supporting structure completely in such cases, methods and devices for reinforcing such an existing supporting [structures] structure have been found. Such supporting structures can be walls of conventional design made of brick, reinforced concrete walls or beams, or beams made of wood, plastic, or steel, for example.

Reinforcement of such supporting structures with steel plates added later has been known for a long time. The steel plates, [in other words] namely strips of sheet steel or steel panels, are glued to one or both sides of the supporting structure, preferably on the side of the supporting structure subjected to tension. The advantage of this method [consists in the fact] is that it can be implemented relatively quickly, but the method imposes strict requirements on the adhesive[, in]. In other words, the preparation of the parts and the performance of the adhesion process must take place under precisely defined conditions to achieve the desired effect. Problems [arise with this method], and especially [in the area of]

corrosion[, in other words] problems, arise when supporting structures such as bridge beams are to be reinforced in this manner in the open[, such as bridge beams for example]. Because of the relatively high weight and the production of such steel panels, the maximum length that can be used is limited. Likewise, for reasons of space, installation in closed spaces can be problematic when the rigid steel panels cannot be transported into the space in question. In addition, the steel plates must be pressed against the supporting structure to be reinforced until the adhesive sets in "overhead" applications[, which]. This also [means] results in high cost.

It is known from [FR] French publication 2 590 608 to use tensioning means in the form of strips of metal or fiber-reinforced plastic with anchors at the ends. In this embodiment, however, there is no flush connection between the tensioning means and the supporting structure [but]. Instead, a connection with the supporting structure is provided only in the two end anchoring points of the tensioning means. Clamping means of this kind are conventionally included when planning the supporting structure, [since] because retrofitting is practically impossible or can be done only at very high cost, since corresponding channels in the supports must be prepared for the clamping means.

Recently, carbon panels (CFK panels) [are] have been glued to the tensioned sides of the supporting structure and, thus, the carrying capacity of such structures is subsequently improved by increasing the supporting resistance and ductility. Advantageously, the simple and economical application of such panels, which have a higher strength than steel panels with a far smaller weight, is provided, and the panels are simpler to install. The corrosion resistance is also better so that such

reinforcements are also suitable for reinforcing supporting structures in the open. However, the end anchoring of the panels [in particular] has proven to be particularly problematical. The danger of the panels coming loose is particularly great in this area, and there is a problem [of introducing] in that the force is introduced from the end of the panel into the beam.

A solution is this regard is known from international publication WO96/21785 [in which]; here, a bore that runs at an obtuse angle or a wedge-shaped recess is made in the beam in which the ends of the CFK panels are inserted and pressed against the beam, possibly by clamps, loops, plates, etc. This results in an improvement in [the] loosening behavior and an improved initiation of the force from the beam into the panel. However, such CFK panels are glued without pretensioning, in other words flexibly, to the beam. As a result [however], much of the reinforcing potential of these panels is not utilized, since panels begin to provide support only after they exceed the basic load, in other words under stress from the useful load itself.

In order to utilize the panels better, the idea has arisen of gluing them pretensioned to the beam. One known solution in this regard provides that short steel plates are glued to the ends of the CFK panels on both sides [and the]. The steel plates are then pulled apart and the CFK panels are pretensioned, and this pretensioned arrangement is glued to the beam to be reinforced. After the glue dries, the panels are pressed at the ends against the beams by plates, loops, etc. and the ends are then cut off with the steel plates. This method, however, is very expensive and cannot be used in all applications. The method of anchoring the panel ends described above is also not suitable [however] for pretensioning at building sites.

Hence, the goal of the present invention is to provide a CFK reinforcing panel in which the introduction of [the] force from the beam into the ends takes place in such fashion that separation becomes practically impossible and which is also suitable for pretensioning.

[This goal is achieved according to the invention by a CFK panel with the features of Claim 1 or by the method according to Claim 11. Preferred embodiments of the invention follow from dependent Claims 2 to 10 and 12 to 14.]

[By] This goal is achieved by splitting the ends of a CFK panel into at least two and preferably three or more end strips. In this way, the surface for connection to an end element is increased considerably. As a result, there is a good initiation of the force into the ends of the CFK panel which can also be pretensioned in simple fashion by such an end element. The end element in block form can be either inserted into a depression in the beam or, in the preferred embodiment, with a wedge-shaped split with a flat or rough bottom, can also be glued and/or doweled or simply bolted flush to the beam. It is this embodiment that is preferably suited for pretensioning which preferably takes place directly through the beam part. For example, this can be done by tensioning against a fitting inserted into the beam.

The splitting of the ends of the CFK panels [can] preferably [take] takes the form either of strips on top of one another or strips that are side-by-side, or in a combination of these two versions.

The ends of the CFK panels can advantageously be split at the building site itself to the required length and dimensions. This makes this system highly universal for the

reinforcement of practically any beam, and the system can be employed with or without pretensioning.

[One embodiment of the] The invention is described in greater detail below with reference to the figures in the enclosed [drawing] drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a cross section through a beam with a CFK panel according to the invention attached to [the] its underside;

Figure 2 shows a cross section through the head part of the CFK panel in Figure 1;

Figure 3 shows a cross section through the end of a CFK panel according to Figures 1 and 2;

Figure 4 shows a cross section through a beam with an additional CFK panel according to the invention mounted on the underside;

Figure 5 shows a cross section through the head part of the CFK panel according to Figure 4;

Figure 6 shows a schematic cross section through an alternative head part of a CFK panel according to the invention;

Figure 7 is a schematic cross section through an additional alternative head part of a CFK panel according to the invention; and

Figure 8 is a top view of another alternative embodiment of the head part of a CFK panel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a cross section through a beam 1 to be reinforced. The ends of the CFK panel 2 used for this purpose are inserted according to the invention in elements, in this case anchor heads 3 and 4. Anchor heads [3, 4] 3 and 4 can be inserted into milled or pointed recesses of beam 1 as shown in this figure. CFK panel 2 is connected with beam 1 over part or all of the area by [means of] a layer of adhesive 5 and the anchor heads [3, 4] 3 and 4 are glued to it as well. In addition, anchor heads [3, 4] 3 and 4 can be connected with the beam by a transverse clamping device 6, shown here simply schematically, resulting in an improved direction of the force through the anchor heads [3, 4] 3 and 4 from the CFK panel 2 into the beam 1. This transverse clamping device 6 can be for example, a threaded rod or dowel guided through the beam 1 and the anchor heads [3, 4] 3 and 4.

The reinforcing device composed of the CFK panel 2 and the anchor heads [3, 4] 3 and 4 can also be simply pretensioned as shown schematically on the right-hand side of Figure 1. For this purpose, for example, an angular fitting 7 can be attached to the underside 1 of the beam[, said]. This fitting [being] is gripped by a tension rod 8 connected at one of its ends by the anchor head 4. It is advantageous [that] to provide both of the anchor heads [3, 4 must be provided] 3 and 4 with such a tensioning device for pretensioning. The clamping device is mounted before gluing and can be removed again after the adhesive cures between the CFK panel 2 or the anchor heads [3, 4] 3 and 4 and the beam 1.

Figure 2 shows a cross section through one of the anchor heads [2] 3. In the anchor head 3, in the form of a parallelepiped, preferably three guide or retaining slots 9 are provided one above the other [which]. These slots can accept the end of CFK panel 2 after it is divided into three tabs 2' as shown in Figure 3.

Retaining slots 9 are spread upward and downward wedgewise and have transverse bores 10. These bores 10 provide additional anchoring points for the adhesive that connects the strips 2' of the CFK panel 2 with the retaining slots 9. In this way, the introduction of tensile forces from the beam 1 through the anchor head 3 into the CFK panel 2 is additionally improved. The great advantage, however, lies in splitting the end of the panel 2 into the strips 2'. This splitting is preferably performed in the fiber direction of the panels and advantageously results in an increase in gluing area without the strength properties of the CFK panel 2 being adversely affected.

In the present example with three strips 2', the gluing area is increased six times [by comparison] with respect to a conventional panel that is simply glued at its end to the beam, and is increased three times over the known solution with a wedge-shaped recess in the beam and adhesion bridges.

In order [in the outlet area of anchor head 3 of CFK panel 2] to prevent bending or tearing in the outlet area of the anchor head 3 of the CFK panel 2 by transverse forces that result from the wedge-shaped or arcuate arrangement of the retaining slots 9, a transverse reinforcement 11 [is advantageously provided] which is only indicated schematically in Figure 2 is provided. For example, this transverse reinforcement 11 can be provided by threaded rods guided through matching bores in anchor head 3 and

tightened by nuts. Thus, any shear stress peaks in the outlet area of anchor head 3 are subject to overpressure and higher shear stresses are permitted in this zone.

In addition, a threaded bore 12 is provided in anchor head 3, for example, into which bore a pretensioning device can be screwed as shown schematically in Figure 1.

Figure 3 shows, as already mentioned, one end of the CFK panel 2 with the end of the panel split into three strips 2'. The CFK panel can be split by conventional means, following cutting to length, to the desired length and the desired number of equally thick strips 2'. Cutting may be performed, for example, by [means of] a plane or knife. It is advantageous in this regard that relatively low requirements are imposed on the quality of the splitting; the important aspect is the division into the correct number of strips 2' to achieve the increase in area for the connection to the anchor head 3.

Figure 4 shows a cross section through a beam 1 with a reinforcing device according to the invention mounted on the underside (tension side), consisting of a CFK panel 2 with anchor heads [12, 13] 12 and 13 attached to the ends. Anchor heads 12 and 13 are so designed that the CFK panel 2 emerges practically at the level of adhesive layer 5 from the anchor heads [12, 13] 12 and 13 and the latter, therefore, must not be depressed in the underside of beam 1 but must also be glued flush to the underside [for example]. Of course, the transverse tensioning devices 6 shown in Figure 1 can also be mounted here to produce a higher pressure and thus a higher tensile strength of the connection between anchor heads [12, 13] 12 and 13 and the underside of the beam. Likewise, these anchor heads [12, 13] 12 and 13, like the embodiment already described above, can be pretensioned simply.

Figure 5 shows a cross section through an anchor head 12 and the corresponding arrangement of the holding slots 9. The bottom slot 9' is parallel to the outside wall 12' of the anchor head 12, resting on beam 1, and the other slots 9 are located at an acute angle pointing outward in the form of a fan. This arrangement offers the same advantages as already described as a result of the increase in the gluing surface of the CFK panel 2 and also allows the flush application of anchor heads [12, 13] 12 and 13 as well without additional recesses in beam 1. These anchor heads [12, 13 as well] 12 and 13 also have transverse reinforcing means 11, as shown schematically in Figure 2, to avoid bending or tearing of anchor heads [12, 13] 12 and 13 in the area where the CFK panel 2 emerges.

As material for the anchor heads 3, 4 and 12, 13, metal [is suitable] which exhibits high strength, ease of machining, and good force initiation properties is suitable, as is plastic, especially when corrosion is expected to be high.

Figure 6 is a schematic view of another embodiment of the reinforcing device according to the invention. The end of the CFK panel 2 is split here into two superimposed strips 2' which come to rest on the outside of a wedge-shaped anchor head 14. There they can be connected to the surface of the anchor head 14 by gluing.

In another embodiment according to the invention, the split strips 2' at the end of the CFK panel 2 are held in an anchor head composed of plates 15 located parallel one on top of the other as shown in a lengthwise section in Figure 7. Here a screw connection 16 can be advantageously employed to press the plate 15 and the strips 2' against one another.

Figure 8 is a top view of another embodiment of the end of the CFK panel 2. Here, the strips 2' are not shown one on top of the other but are located laterally side by side. Here again, the split is preferably made in the fiber direction of the CFK panel 2.

The reinforcing devices according to the invention are especially suited for rehabilitating existing concrete beam structures, such as ceilings or bridge beams. However, they can also be used for all known applications of conventional CFK panels, for example masonry and wooden supporting structures. The ease with which they can be pretensioned permits a greater utilization of the strength properties of the CFK panels than in known methods. In addition, pretensioning means that on the tension side of an existing supporting element, pre-pressing takes place that is advantageous, for example, in [the case of] bridge beams.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

WO99/10613

PCT/CH98/00346

Reinforcing Device for Supporting Structures

The present invention relates to a reinforcing device according to the preamble of Claim 1 as well as a method for reinforcing beams according to the preamble of Claim 11.

When rehabilitating supporting structures in existing buildings, the problem often arises that the supporting structure is to be adapted for new load cases that exceed the former dimensions. In order to avoid replacing the supporting structure completely in such cases, methods and devices for reinforcing such existing supporting structures have been found. Such supporting structures can be walls of conventional design made of brick, reinforced concrete walls or beams, or beams made of wood, plastic, or steel for example.

Reinforcement of such supporting structures with steel plates added later has been known for a long time. The steel plates, in other words strips of sheet steel or steel panels, are glued to one or both sides of the supporting structure, preferably on the side of the supporting structure subjected to tension. The advantage of this method consists in the fact that it can be implemented relatively quickly but imposes strict requirements on the adhesive, in other words the preparation of the parts and the performance of the adhesion process must take place under precisely defined conditions to achieve the desired effect. Problems arise with this method especially in the area of corrosion, in other words when supporting structures are to be reinforced in this manner in the open, such as bridge beams for example. Because of the relatively high weight and the production of such steel panels, the maximum length that can be used is limited. Likewise, for reasons of space, installation in closed spaces can be problematic when the rigid steel panels cannot be transported into the space in question. In addition, the steel plates must be pressed against the supporting structure to be reinforced until the adhesive sets in "overhead" applications, which also means high cost.

It is known from FR 2 590 608 to use tensioning means in the form of strips of metal or fiber-reinforced plastic with anchors at the ends. In this embodiment however there is no flush connection between the tensioning means and the supporting structure but a connection with the supporting structure is provided only in the two end anchoring points of the tensioning means. Clamping means of this kind are conventionally included when planning the supporting structure since retrofitting is practically impossible or can be done only at very high cost,

since corresponding channels in the supports must be prepared for the clamping means.

Recently, carbon panels (CFK panels) are glued to the tensioned sides of the supporting structure and thus the carrying capacity of such structures is subsequently improved by increasing the supporting resistance and ductility. Advantageously, the simple and economical application of such panels which have a higher strength than steel panels with a far smaller weight are simpler to install. The corrosion resistance is also better so that such reinforcements are also suitable for reinforcing supporting structures in the open. However, the end anchoring of the panels in particular has proven to be problematical. The danger of the panels coming loose is particularly great in this area and there is a problem of introducing the force from the end of the panel into the beam.

A solution is this regard is known from WO96/21785 in which a bore that runs at an obtuse angle or a wedge-shaped recess is made in the beam in which the ends of the CFK panels are inserted and pressed against the beam, possibly by clamps, loops, plates, etc. This results in an improvement in the loosening behavior and an improved initiation of the force from the beam into the panel. However, such CFK panels are glued without pretensioning, in other words flexibly to the beam. As a result however, much of the reinforcing potential of these panels is not utilized since panels begin to provide support only after they exceed the basic load, in other words under stress from the useful load itself.

In order to utilize the panels better, the idea has arisen of gluing them pretensioned to the beam. One known solution in this regard provides that short steel plates are glued to the ends of the CFK panels on both sides and the steel plates are then pulled apart and the CFK panels are pretensioned and this pretensioned arrangement is glued to the beam to be reinforced. After the glue dries, the panels are pressed at the ends against the beams by plates, loops, etc. and the ends are then cut off with the steel plates. This method however is very expensive and cannot be used in all applications. The method of anchoring the panel ends described above is not suitable however for pretensioning at building sites.

Hence, the goal of the present invention is to provide a CFK reinforcing panel in which the introduction of the force from the beam into the ends takes place in such fashion that separation becomes practically impossible and which is also suitable for pretensioning.

This goal is achieved according to the invention by a CFK panel with the features of Claim 1 or by the method according to Claim 11. Preferred embodiments of the invention follow from dependent Claims 2 to 10 and 12 to 14.

By splitting the ends of a CFK panel into at least two and preferably three or more end strips, the surface for connection to an end element is increased considerably. As a result, there is a good initiation of the force into the ends of the CFK panel which can also be pretensioned in simple fashion by such an end element. The end element in block form can be either inserted into a depression in the beam or in the preferred embodiment, with a wedge-shaped split with a flat or rough bottom, can also be glued and/or doweled or simply bolted flush to the beam. It is this embodiment that is preferably suited for pretensioning which preferably takes place directly through the beam part. For example, this can be done by tensioning against a fitting inserted into the beam.

The splitting of the ends of the CFK panels can preferably take the form either of strips on top of one another or strips that are side-by-side, or in a combination of these two versions.

The ends of the CFK panels can advantageously be split at the building site itself to the required length and dimensions. This makes this system highly universal for the reinforcement of practically any beam and can be employed with or without pretensioning.

One embodiment of the invention is described in greater detail below with reference to the figures in the enclosed drawing.

Figure 1 shows a cross section through a beam with a CFK panel according to the invention attached to the underside;

Figure 2 shows a cross section through the head part of the CFK panel in Figure 1;

Figure 3 shows a cross section through the end of a CFK panel according to Figures 1 and 2;

Figure 4 shows a cross section through a beam with an additional CFK panel according to the invention mounted on the underside;

Figure 5 shows a cross section through the head part of the CFK panel according to Figure 4;

Figure 6 shows a schematic cross section through an alternative head part of a CFK panel according to the invention;

Figure 7 is a schematic cross section through an additional alternative head part of a CFK panel according to the invention;

Figure 8 is a top view of another alternative embodiment of the head part of a CFK panel.

Figure 1 shows a cross section through a beam 1 to be reinforced. The ends of the CFK panel 2 used for this purpose are inserted according to the invention in elements, in this case anchor heads 3 and 4. Anchor heads 3, 4 can be inserted into milled or pointed recesses of beam 1 as shown in this figure. CFK panel 2 is connected with beam 1 over part or all of the area by means of a layer of adhesive 5 and the anchor heads 3, 4 are glued to it as well. In addition, anchor heads 3, 4 can be connected with the beam by a transverse clamping device 6, shown here simply schematically, resulting in an improved direction of the force through anchor heads 3, 4 from CFK panel 2 into beam 1. This transverse clamping device 6 can be for example a threaded rod or dowel guided through beam 1 and anchor heads 3, 4.

The reinforcing device composed of CFK panel 2 and anchor heads 3, 4 can also be simply pretensioned as shown schematically on the right-hand side of Figure 1. For this purpose, for example, an angular fitting 7 can be attached to the underside 1 of the beam, said fitting being gripped by a tension rod 8 connected at one of its ends by anchor head 4. It is advantageous that both anchor heads 3, 4 must be provided with such a tensioning device for pretensioning. The clamping device is mounted before gluing and can be removed again after the adhesive cures between CFK panel 2 or anchor heads 3, 4 and beam 1.

Figure 2 shows a cross section through one of anchor heads 2. In anchor head 3 in the form of a parallelepiped, preferably three guide or retaining slots 9 are provided one above the other which can accept the end of CFK panel 2 divided into three tabs 2' as shown in Figure 3.

Retaining slots 9 are spread upward and downward wedgewise and have transverse bores 10. These bores 10 provide additional anchoring points for the adhesive that connects strips 2' of CFK panel 2 with retaining slots 9. In this way, the introduction of tensile forces from beam 1 through anchor head 3 into CFK panel 2 is additionally improved. The great advantage however lies in splitting the end of panel 2 into strips 2'. This splitting is preferably performed in the fiber direction of the panels and advantageously results in an increase in gluing area without the strength properties of the CFK panel 2 being adversely affected.

In the present example with three strips 2', the gluing area is increased six times by comparison with a conventional panel that is simply glued at its end to the beam and is increased three times over the known solution with a wedge-shaped recess in the beam and adhesion bridges.

In order in the outlet area of anchor head 3 of CFK panel 2 to prevent bending or tearing of the anchor head by transverse forces that result from the wedge-shaped or arcuate arrangement of retaining slots 9, a transverse reinforcement 11 is advantageously provided which is only indicated schematically in Figure 2. For example, this transverse reinforcement 11 can be provided by threaded rods guided through matching bores in anchor head 3 and tightened by nuts. Thus, any shear stress peaks in the outlet area of anchor head 3 are subject to overpressure and higher shear stresses are permitted in this zone.

In addition, a threaded bore 12 is provided in anchor head 3 for example into which bore a pretensioning device can be screwed as shown schematically in Figure 1.

Figure 3 shows, as already mentioned, one end of the CFK panel 2 with the end of the panel split into three strips 2'. The CFK panel can be split by conventional means following cutting to length, to the desired length and the desired number of equally thick strips 2', for example by means of a plane or knife. It is advantageous in this regard that relatively low requirements are imposed on the quality of the splitting; the important aspect is the division into the correct number of strips 2' to achieve the increase in area for the connection to the anchor head 3.

Figure 4 shows a cross section through a beam 1 with a reinforcing device according to the invention mounted on the underside (tension side), consisting of a CFK panel 2 with anchor heads 12, 13 attached to the ends. Anchor heads 12 and 13 are so designed that the CFK panel 2 emerges practically at the level of adhesive layer 5 from anchor heads 12, 13 and the latter therefore must not be depressed in the underside of beam 1 but must also be glued flush to the underside for example. Of course, the transverse tensioning devices 6 shown in Figure 1 can also be mounted here to produce a higher pressure and thus a higher tensile strength of the connection between anchor heads 12, 13 and the underside of the beam. Likewise, these anchor heads 12, 13, like the embodiment already described above, can be pretensioned simply.

Figure 5 shows a cross section through an anchor head 12 and the corresponding arrangement of the holding slots 9. The bottom slot 9' is parallel to the outside wall 12' of anchor head 12, resting on beam 1, and the other slots 9 are located at an acute angle pointing outward in the form of a fan. This arrangement offers the same advantages as already described as a result of the increase in the gluing surface of the CFK panel 2 and also allows the flush application of anchor heads 12, 13 as well without additional recesses in beam 1. These anchor heads 12, 13 as well have transverse reinforcing means 11, as shown schematically in Figure 2, to avoid bending or tearing of anchor heads 12, 13 in the area where the CFK panel 2 emerges.

As material for anchor heads 3, 4 and 12, 13, metal is suitable which exhibits high strength, ease of machining, and good force initiation properties, as is plastic, especially when corrosion is expected to be high.

Figure 6 is a schematic view of another embodiment of the reinforcing device according to the invention. The end of CFK panel 2 is split here into two superimposed strips 2' which come to rest on the outside of a wedge-shaped anchor head 14. There they can be connected to the surface of anchor head 14 by gluing.

In another embodiment according to the invention, the split strips 2' at the end of CFK panel 2 are held in an anchor head composed of plates 15 located parallel one on top of the other as shown in a lengthwise section in Figure 7. Here a screw connection 16 can be advantageously employed to press plate 15 and strips 2' against one another.

Figure 8 is a top view of another embodiment of the end of CFK panel 2. Here the strips 2' are not shown one on top of the other but are located laterally side by side. Here again, the split is preferably made in the fiber direction of the CFK panel 2.

The reinforcing devices according to the invention are especially suited for rehabilitating existing concrete beam structures, such as ceilings or bridge beams. However, they can also be used for all known applications of conventional CFK panels, for example masonry and wooden supporting structures. The ease with which they can be pretensioned permits a greater utilization of the strength properties of the CFK panels than in known methods. In addition, pretensioning means that on the tension side of an existing supporting element, pre-pressing takes place that is advantageous for example in the case of bridge beams.

Claims

1. Reinforcing device for supporting structures (1) with CFK panel (2) characterized in that at least one end of CFK panel (2) is split into at least two strips (2') and terminates in an end element (3, 4; 12, 13).

2. Reinforcing device according to Claim 1 characterized in that each of the two ends of CFK panel (2) terminates in an end element (3, 4; 12, 13).

3. Reinforcing device according to Claim 1 or 2 characterized in that the strips (2') are inserted at least partially into retaining slots (9; 9') of end element (3, 4; 12, 13) that are preferably located wedgewise relative to one another.

4. Reinforcing device according to one of Claims 1 to 3 characterized in that the panel ends (2') are split into superimposed strips of approximately equal thickness.

5. Reinforcing device according to one of Claims 1 to 4 characterized in that retaining slots (9) of end element (3, 4; 12, 13) have a rough or corrugated surface.

6. Reinforcing device according to one of Claims 1 to 5 characterized in that bores (10) located transversely to the surface of the panel are located in end element (3) in the vicinity of retaining slots (9).

7. Reinforcing device according to one of Claims 1 to 6 characterized in that the end element (3, 4; 12, 13) is a parallelepiped made of metal or plastic.

8. Reinforcing device according to one of Claims 1 to 7 characterized in that the end element (3, 4; 12, 13) in the vicinity of the outlet of the CFK panel (2) has reinforcing devices (11), preferably threaded bolts, located transversely to the outlet direction.

9. Reinforcing device according to one of Claims 1 to 8 characterized in that the end element (3, 4; 12, 13) has a force-introduction point, preferably a threaded bore (12) opposite the outlet of the CFK panel.

10. Reinforcing device according to one of Claims 1 to 9 characterized in that the retaining slots (9) are located wedgewise in end element (3, 4; 12, 13) in such fashion that the lowest retaining slot (9') is parallel to the outlet direction of

panel (2) and the other retaining slots (9) are each located fanwise with an increasing angle from the outlet opening.

11. Method for reinforcing supporting elements (1) with reinforcing devices according to one of Claims 1 to 10 characterized in that the CFK panels (2) cut to the appropriate length are separated or split at at least one end into at least two strips (2') of approximately the same thickness or width and are brought into a connection with an end element (3, 4; 12, 13) and this arrangement is glued to the tension side of the supporting element (1) to be reinforced.

12. Method according to Claim 11 characterized in that the strips (2') of CFK panel (2) are introduced into separate retaining slots (9, 9') of an end element (3, 4; 12, 13) preferably arranged fanwise with respect to one another and glued there or soaked with an adhesive.

13. Method according to Claim 11 or 12 characterized in that the ends of the CFK strips (2) are each separated or split into three strips (2') and the arrangement, before gluing with supporting element (1), is pretensioned relative to the latter by clamping means (7, 8) and then glued in the pretensioned state to supporting element (1).

14. Method according to one of Claims 11 to 13 characterized in that the CFK panel (2) is split in the fiber direction.

ABSTRACT OF THE DISCLOSURE

The ends of carbon plates reinforcing supporting elements, such as concrete beams, are divided into at least two splines having approximately the same thickness and are glued in the appropriate retaining slots of a terminal element. The splines form an angle in relation to each other. This assembly is then glued to the traction side of the supporting element, whereby the carbon plates are directly prestressed by the terminal elements in relation to the supporting element. The terminal element can be inserted into an appropriate groove in the supporting element or glued directly on the surface of the supporting element and/or doweled, optionally by using a transverse tensioning device.

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER 2046/48639

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

REINFORCEMENT DEVICE FOR SUPPORTING STRUCTURES

the specification of which (check only one item below):

[ ] is attached hereto.

[ ] was filed as United States application
Serial No. _____
on _____
and was amended
on _____ (if applicable).

[X] was filed as PCT international application
Number PCT/CH98/00346
on 18 August 1998
and was amended under PCT Article 19
on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. §1.56(a).

I hereby claim foreign priority benefits under Title 35, United State Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Switzerland	1987/97	26 August 1997	[X] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

Combined Declaration For Patent Application and Power of Attorney (Continued) (includes Reference to PCT international Applications	ATTORNEY'S DOCKET NUMBER 2046/48639

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national of PCT international filing date of this application:

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U.S. APPLICATIONS		STATUS *(Check one)*		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (IF ANY)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
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DATE 16. March 2000	Date	DATE